

# Science and Man . . . By Joshua Lederberg

## The Versatile Embryo

GENETIC FATALISM is one of the most prevalent and destructive fallacies about human biology. This



doctrine holds that the quality of an individual is rigidly determined at the time of fertilization. It ignores the intricate and marvelous

processes by which the egg becomes an independent adult organism. Because of these processes, experimental embryology stands next to genetics as a central subject of the modern humanities, the scientific studies of the roots of human nature.

For many years, research in experimental embryology concentrated on the most convenient laboratory material: some marine invertebrates, chickens and especially frogs. But it was hard to perceive the human implications and parallels of laboratory curiosities, like some of the strangely formed tadpoles that could be hatched out of variously treated eggs. The perversity of nature also caused frustration. Species whose eggs were convenient for experimental embryology were almost always hard to rear to maturity for use in refined genetic studies.

DURING THE LAST 20 years, however, techniques have been perfected for embryological experiments on the laboratory mouse, already widely used for studies in genetics and related aspects of cell biology, cancer research and immunology and other experimental work.

Except for the important difference in brain growth, the principles of development in mouse and man are basically the same.

A striking answer to genetic fatalism is the fact that there need not be even a numerical correspondence be-

tween fertilized egg and adult. In exceptional circumstances, one egg may produce several offspring, and several eggs may produce but one. Thus, if two eggs or early embryos are held together, they usually fuse to produce a single organism. Conversely, if an early embryo is pinched and separated into two halves, it will generate two intact offspring, not two half-organisms. The production of half-organisms, the result of a kind of developmental fatalism, is found in some marine worms, but not in vertebrates.

Study of identical twins had long indicated that man resembled the frog in these development patterns. Now genetic evidence makes it clear that identical twins come from a single fertilized egg, which has split during early development.

NEW EXPERIMENTAL evidence comes from Dr. Beatrice Mintz of the Institute for Cancer Research, Philadelphia. She has developed the technique of fusing early embryos of the mouse, then implanting them in the uterus of a foster mother. These complexes often develop normally, and a viable litter is delivered at term. When inbred strains of different coat color are combined, the adult animals display clear evidence of their composite origin, two embryos having been merged into one adult.

There is no apparent reason, other than compelling research interest, to conduct such a drastic experiment in man, but neither are there any overriding, obvious, technical obstacles. There is a 50 per cent risk that the

two embryos being fused are of opposite sex, and if this is so the fusion produces a hermaphrodite with imperfect, bisexual development. Dr. Mintz's experiments may shed light on this distressing mishap in man, perhaps, sometimes the result of a natural accident of embryonic fusion. Rare mosaics of other kinds, such as mixtures of blood cell type, have also been described. They may have a similar origin, although the exchange of cells probably occurs most often at a later stage.

The technique of embryo fusion should be especially valuable for contrasting the effects of specific genes which act inexorably within single cells, with those in which interaction between cells and tissues plays a more important role. For example, the primary sex cells seem to illustrate the first principle, whereas secondary sex characteristics are very much influenced by hormones secreted by other tissues.

EARLY GRAFTING leads to a compatibility of tissues that cannot be achieved readily in adult life. The embryo fusions are therefore important for studying the biology of tissue grafting and rejection, so important for organ transplantation.

However, the main lesson we learn from these experiments is the subtlety of the development blueprint. Left alone, the egg would make one whole organism. Under the influence of another, it makes a perfectly complementary part. How one plus one can make one is among the most challenging problems of biology today.

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